IS 11869 (1987): Hand and/or Foot Contamination Monitors and Warning Assemblies [LITD 8: Electronic Measuring Instruments, Systems and Accessories]

BLANK PAGE

IS : 11869 - 1987
IEC Pub 504 (1975)

UDC 539·12·074

(Reaffirmed 2006)

Indian Standard

SPECIFICATION FOR HAND AND/OR FOOT CONTAMINATION MONITORS AND WARNING ASSEMBLIES

National Foreword

This Indian Standard, which is identical with IEC Pub 504 (1975) 'Hand and/or foot contamination monitors and warning assemblies' issued by the International Eleetrotechnical Commission (IEC) was adopted by the Indian Standards Institution on the recommendation of the Nuclear Instrumentation Sectional Committee and approval of the Electronics and Telecommunication Division Council.

Wherever the words 'International Standard' appear referring to this standard, they shall be read as 'Indian Standard'.

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

Nuclear Instrumentation Sectional Committee, LTDC 26 [Ref : Doc : LTDC 26 (1033)]

Adopted 28 January 1987 | | Gr 7

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

CONTENTS

1. Scope and object

1.1 The present publication applies to contamination monitors and warning assemblies specifically provided for hands and/or feet, irrespective of whether or not the hands or feet are bare.

These assemblies comprise at least:

— a detector sub-assembly;

— a measuring sub-assembly.

1.2 The publication is applicable to:

— alpha hand and/or foot contamination monitors;

— alpha hand and/or foot contamination warning assemblies;

— beta hand and/or foot contamination monitors;

— beta hand and/or foot contamination warning assemblies,

as defined in Clause 2.

1.3 If an assembly has been designed to carry out combined functions, it shall comply with the requirements pertaining to these different functions. If, on the other hand, it has been designed to perform one function, and in addition, is also capable of carrying out other functions, then it shall comply with the requirements for the first function, and it would be desirable for it to meet the requirements pertaining to the others.

1.4 The requirements given below correspond to assemblies currently being manufactured. It is, however, possible to use assemblies which do not meet the numerical requirements set out below when such requirements are not considered essential for a given purpose.

In such cases, the performance of the assemblies shall be specified by agreement between the manufacturer and the user, but the determination of the characteristics of the assemblies shall conform to the methods given in the present publication.

1.5 The publication is not applicable to the operating characteristics of indicating or recording instruments as such (e.g. indicating meters, recorders, alarms, etc.).

The characteristics of such instruments shall be in conformity with the general specifications appropriate to them.

1.6 This publication specifies for the above-described assemblies: general test procedures, radiation characteristics, operating and mechanical characteristics, and also the identification certificate.

2. Terminology

2.1 *Degrees of requirements*

In the present publication, the following terminology is employed:

— the word "shall" signifies a mandatory requirement;

— the word "should" signifies strongly recommended;

— the word "may" signifies an acceptable method, or example of good practice.

2.2 *Definitions*

For the purpose of this publication, the following definitions of measuring assemblies shall apply.

2.2.1 *Hand and/or foot contamination meter*

A radiation meter designed to measure hand and/or foot contamination and including one or several radiation detectors and associated sub-assemblies or basic functional units.

2.2.2 *Hand and/or foot contamination warning assemblies*

An assembly intended to give a warning (usually visual or audible) that the degree of contamination of the surface of the hand and/or foot exceeds some predetermined value or that the measured value is not within some predetermined limits.

2.2.3 *Hand and/or foot contamination monitor*

An assembly having the functions of both hand and/or foot contamination meter and a hand/or foot contamination warning assembly.

2.2.4 *Response*

The quotient of the output variable of the measuring assembly or sub-assembly by the value of the measured quantity.

2.2.5 *Thin radioactive source*

For the purpose of this publication, the following definition shall apply for a thin radioactive source: a radioactive source of which the thickness of the radioactive deposit is sufficiently small to ensure that absorption within the material of the source of the radiation of interest, emitted by the radioactive deposit, is negligible.

2.2.6 *Coefficient of variation*

Ratio of the standard deviation σ to the value of the arithmetic mean $\bar{x}$ of a set of n measurements x_i given by the following formula:

$$V = \frac{\sigma}{\bar{x}} = \frac{1}{\bar{x}} \sqrt{\frac{1}{n-1} \Sigma (x_i - \bar{x})^2}$$

2.2.7 *Conventionally true contamination level*

The best approximate value of the true surface contamination.

2.3 *Test nomenclature*

2.3.1 *Qualification tests*

Set of tests performed in order to verify that the requirements of a specification are fulfilled.

Note. — Qualification tests are subdivided into type tests and routine tests, as defined below.

2.3.1.1 *Type tests*

Those qualification tests which are performed on one assembly or on a small number of assemblies, considered to be representative of an industrial production, and which, in principle, are not repeated on each assembly.

2.3.1.2 *Routine tests*

Those qualification tests which are performed on each production assembly.

2.3.2 *Acceptance tests*

Contractual tests performed in the presence of a customer or his representative in order to verify the quality of a delivery. These tests are, in general, selected from the qualification tests, although the methods of performing them may be different.

3. Classification of assemblies

The assemblies are classified:

3.1 According to the type of radiation as:

— alpha contamination monitors (or warning assemblies),
— beta contamination monitors (or warning assemblies),
— alpha-beta contamination monitors (or warning assemblies).

3.2 According to their function as:

- contamination monitors,
- contamination warning assemblies.

3.3 According to the type of surface as:

- assemblies designed to. monitor contamination of hands,
- assemblies designed to monitor contamination of feet,
- assemblies designed to monitor contamination of both feet and hands.

3.4 According to their power supplies as:

- assemblies powered by the mains,
- assemblies powered by primary or secondary batteries (emergency supply).

3.5 According to their type as:

- assemblies without background compensation,
- assemblies with background compensation.

4. Display

The display of the assembly shall be related to the counting rate or to the number of counts in a predetermined time.

The scale shall be graduated either in these units or as a percentage of a predetermined maximum level. Whatever the graduation of the scale, the manufacturer shall also state the relationship between this graduation and the contamination level in μCi for a given energy or radionuclide.

In countries in which requirements specify a maximum permissible level, this may be taken as the predetermined maximum level.

5. General test procedures

5.1 *Nature of tests*

With the exception of the routine test described in Sub-clause 6.5.2, all the tests enumerated in the following sections are to be considered as type tests (Sub-clause 2.3.1.1).

Nevertheless, some of these tests may, by agreement between manufacturer and purchaser, be considered acceptance tests.

5.2 *Basic principles*

Reference conditions are given by the second column of Table I unless otherwise specified by the manufacturer.

Except where otherwise specified, the tests in this standard shall be carried out under standard test conditions given in the third column of Table I.

5.3 *Reference radioactive source dimensions*

The calibration reference sources* for all tests shall have areas equivalent to the hand or foot.

Unless otherwise specified in the method, the dimensions of the reference sources shall be:

15 cm × 10 cm for hand monitors and warning assemblies,
30 cm × 10 cm for foot monitors and warning assemblies.

The activity distribution of such reference sources shall be as uniform as possible.

---

* The activities of the reference sources are specified in Sub-clauses 6.1.2.1 and 6.1.2.2.

5.4 *Statistical fluctuations*

For any test involving the use of radiation, if the magnitude of the statistical fluctuations of the indication arising from the random nature of radiation alone is a significant fraction of the variation of the indication permitted in the test, then a sufficient number of readings shall be taken to ensure that the mean value of such readings may be estimated with sufficient accuracy to demonstrate compliance with the test in question.

The interval between such readings shall be sufficient to ensure that the readings are statistically independent.

TABLE I

Reference conditions and test conditions

Influence	Reference conditions (unless otherwise indicated by the manufacturer)	Standard test conditions * (unless otherwise indicated by the manufacturer)
Warm-up time	> 15 min	≥ 15 min
Ambient temperature	20 °C	18 °C to 22 °C
Relative humidity	65%	55% to 75%
Atmospheric pressure	101.3 kPa	86 kPa to 106 kPa
Power supply voltage	Nominal power supply voltage U_N	Nominal power supply voltage $U_N \pm 1\%$
Power supply frequency	Nominal frequency	Nominal frequency ± 2%
Power supply waveform	Sinusoidal	Sinusoidal with total harmonic distortion lower than 5%
External gamma radiation at the level of the detector	Less than 20 μR/h	Less than 25 μR/h
Electromagnetic field of external origin	Negligible	Less than the lowest value that causes interference
Magnetic induction of external origin	Negligible	Less than twice the induction due to the Earth's magnetic field at the place of test
Setting of the assembly control	Set up for normal operation	Set up for normal operation
Contamination by radioactive elements	Negligible	Less than the lowest value that can be detected by the assembly

* The standard test conditions represent the permitted tolerances on the reference conditions. See IEC Publication 359.

6. Radiation characteristics

6.1 *Surface contamination response*

6.1.1 *Mode of expression*

The surface contamination response of the assembly for the reference source shall be given in scale units per surface activity.

Scale units, as selected according to Clause 4, are:

1) counts [*n*] per second, or
2) counts [*n*] in a predetermined time, or
3) a predetermined maximum permissible level (MPL).

Hence, the surface contamination response is expressed as follows:

1) $\frac{n \cdot s^{-1}}{\mu Ci \cdot cm^{-2}}$ (name of radionuclide)

2) $\frac{n}{\mu Ci \cdot cm^{-2}}$ (name of radionuclide)

3) MPL (name of radionuclide)

6.1.2 *Method of measuring the surface contamination response*

6.1.2.1 *Alpha monitors and warning assemblies*

A thin uncollimated alpha emitting radioactive source such as ^{239}Pu or ^{241}Am, having the dimensions stated in Sub-clause 5.3, the activity of which is known with an accuracy compatible with that of the measurement to be made and is about:

1.5×10^{-3} µCi for each face of the source for hand monitors and warning assemblies,

3×10^{-3} µCi for foot monitors and warning assemblies

shall be used to measure the surface contamination response. This source shall be placed in the normal position of use as indicated by the manufacturer.

6.1.2.2 *Beta monitors and warning assemblies*

A thin uncollimated beta emitting reference radioactive source, having the dimensions stated in Sub-clause 5.3, the activity of which is known with an accuracy compatible with that of the measurement to be made and is about:

1.5×10^{-2} µCi for each face of the source for hand monitors or warning assemblies designed for beta emitters of maximum energy above 250 keV,

3×10^{-2} µCi for foot monitors or warning assemblies designed for beta emitters of maximum energy above 250 keV,

shall be used to measure the surface contamination response. This source shall be placed in the normal position of use as indicated by the manufacturer.

6.1.3 *Precautions and corrections*

a) In the absence of a source having the dimensions given in Sub-clause 5.3, a source of a smaller area may be used. Measurements shall be taken for a sufficient number of positions and the necessary corrections applied to obtain comparable accuracy.

b) In the case where the detector sub-assembly is provided with a protective grill, it should be noted that the characteristics of the sub-assembly depend on the position of the grill in relation to the sensitive area of the detector and to the source.

c) The number of counts shall be such that the statistical uncertainty may be considered negligible in relation to the accuracy stated for measurement.

6.2 *Alarm threshold*

The assembly shall be designed to allow the alarm threshold to be set at the levels given in the following table, verification of the alarm threshold being a type test.

TABLE II

Alarm threshold levels

Monitors and warning assemblies designed for surveying	One side of the hand	Both sides of the hand	The sole of the foot
α above 4 MeV	$5 \cdot 10^{-4}$ µCi	10^{-3} µCi	10^{-3} µCi
β above 250 keV	$5 \cdot 10^{-3}$ µCi	10^{-2} µCi	10^{-2} µCi
β below 250 keV	to be stated		

6.3 *Uniformity of detector response*

6.3.1 *Dependence of response on source position*

The response of the detector to a point source situated on the surface under examination will, in general, vary with the position of the source relative to the detector sub-assembly and the transmission of the protective grill.

The manufacturer shall state:

a) the variation in response of the detector with source position over the area of the hand or foot as appropriate (this information may be given as a diagram),

b) the transmission of the grill.

The manufacturer shall indicate the source (e.g. $^{90}Sr/^{90}Y$) with which the measurements of points *a)* and *b)* have been made.

6.3.2 *Maximum permissible value for uniformity error*

(Under consideration, since a conventional but precise definition of uniformity should first be given.)

6.4 *Accuracy of response to the reference radiation*

The accuracy of an assembly characterizes the deviation of the measured results obtained from acceptance tests, with respect to the value indicated by the manufacturer according to Sub-clause 6.1.

The accuracy of an assembly should not be confused with that of the rate meter.

6.4.1 *Mode of expression*

The intrinsic error E, of the indication of the assembly, expressed in % is given by the relationship:

$$E = 100 \frac{\overline{S_i} - S_v}{S_v}$$

where

S_i = indicated contamination level (S_i may be the mean of several measured values S_i, in accordance with Sub-clause 6.1.3 *a)*).

S_v = conventionally true contamination level.

6.4.2 *Requirements*

The manufacturer shall state the response of the detector sub-assembly as a function of the activity being measured. The intrinsic error of an assembly shall not exceed ±30% over the whole range of alarm thresholds specified by the manufacturer.

6.4.3 *Method of test* *

The tests shall be performed as described in:

— Sub-clause 6.1.2.1 for alpha monitors,

— Sub-clause 6.1.2.2 with one radioactive source only, preferably $^{90}Sr/^{90}Y$, for beta monitors.

The manufacturer shall guarantee that each apparatus will satisfy the requirements of Sub-clause 6.4.2. The user may require the test to be carried out on every assembly.

6.5 *Variation of response with radiation energy*

6.5.1 *Alpha contamination monitors and warning assemblies*

No specification.

6.5.2 *Beta contamination monitors and warning assemblies*

6.5.2.1 *Requirements*

The surface activity response of the assembly shall be measured with a source of $^{90}Sr/^{90}Y$ or ^{204}Tl and at least three other beta emitters where maximum energies are distributed as follows:

— one < 0.4 MeV,

— one between 0.4 MeV and 1 MeV,

— one > 1.0 MeV.

---

* Provided the maximum count rate required is such that the loss due to the finite resolution time of the assembly is less than 10%, these tests may be performed by electronic pulse injection of the appropriate count rates. In this case, the form and duration of the injected pulses must be similar to those delivered by the detector in response to radiation.

By way of information, a list of suitable radionuclides is given below:

— ^{14}C (maximum energy 0.155 MeV). Precautions should be taken when using this radionuclide owing to the difficulty of calibration and effects due to self-absorption;
— ^{147}Pm (maximum energy 0.22 MeV). Precautions should be taken to ensure that contamination from ^{146}Pm is low enough not to disturb the calibration;
— ^{60}Co (maximum energy 0.31 MeV). Precautions should be taken when using this radionuclide. The sources used should be very thin in order to minimize the emission of secondary electrons due to gamma radiation;

— ^{185}W (maximum energy 0.43 MeV);
— ^{204}Tl (maximum energy 0.77 MeV);
— ^{210}Bi (maximum energy 1.17 MeV);
— ^{89}Sr (maximum energy 1.46 MeV). Care must be taken to make due allowance for the short half-life of this material.

The manufacturer shall state:

a) The radionuclides for which the response as a function of surface contamination has been measured.

b) The value of the response as a function of the surface contamination for each one of them.

c) The beta particle energy for which the response is no more than 10% of that obtained with a $^{90}Sr/^{90}Y$ or ^{204}Tl source if the energy exceeds the maximum beta energy from ^{14}C. The measurement with $^{90}Sr/^{90}Y$ or ^{204}Tl shall be a routine test. The measurements with other radioactive sources shall be considered as type tests.

TABLE III

Tests performed with variation of influence quantities

Influence quantity	Range of values of influence quantity	Limits of variation of indication
Ambient temperature	Indoor use: +10 °C to +35 °C Outdoor use * : −10°C to +40°C −25 °C to +50°C	± 10% ± 20% ± 50%
Supply voltage U for mains operated assemblies	From 88% U_N to 110% U_N	± 10%
Gamma radiation	Alpha contamination monitors: 2.5 mR/h	20% of the predetermined maximum contamination level or 10% of the most sensitive linear range for linear scaled assemblies or 10% of the lowest significant decade for logarithmically scaled assemblies
	Beta contamination monitors without background compensation: increase of 50 µR/h in exposure rate	30% when indication is greater than 50% of full scale deflection on the most sensitive range or greater than 50% of the least significant decade for logarithmically scaled assemblies
	Beta contamination monitors with background compensation: under an exposure rate ≤ 500 µR/h	50% of full scale deflection on the most sensitive range in the case of linearly scaled assemblies or 50% of the least significant decade in the case of logarithmical scales from the indication given with an exposure rate lower than 20 µR/h

* Assemblies intended for temperate climates. For hotter or colder climates, different limits may be specified by agreement between the purchaser and the manufacturer.

6.5.2.2 *Method of test*

The test for the variation of response with beta radiation energy should be carried on with sources of dimensions stated in Sub-clause 5.3, whose activity is known with an accuracy compatible with that of the measurement to be made.

The source shall be placed in the normal position of use and the indication noted.

6.6 *Variations in the indications of the assembly*

For each influence quantity taken separately, with the remaining influence quantities maintained within the ranges given in Table I, a nominal operating range is defined within which the variation in indication shall remain within the limits stated by the manufacturer, which limits shall in no case exceed the values laid down in Table III. The variation is determined in relation to the value fixed in the reference conditions.

These tests are intended as type tests, the fraction of assemblies sampled being fixed by agreement between the manufacturer and the user.

7. Response to other ionizing radiations

Assemblies shall be designed so as to limit as far as possible the influence of other ionizing radiations.

7.1 *Gamma radiation*

The exposure rates given below may conveniently be provided by a sealed source of ^{137}Cs at a minimum distance from the assembly to be specified by the manufacturer.

7.1.1 *Requirements*

The response of both alpha and beta contamination measuring assemblies to gamma radiation shall be stated. When the assembly is provided with a system to compensate for the presence of gamma radiation, then the type of system shall be stated and the upper limit of exposure rate for satisfactory operation of the compensation.

Such response shall be measured according to the methods given in Sub-clauses 7.1.3 and 7.1.5 and the resultant values should not be greater than those indicated in Sub-clauses 7.1.2 and 7.1.4 (also in Table III).

7.1.2 *Requirements for alpha contamination monitors*

When the detector is subjected to an exposure rate of 2.5 mR/h, the change in indication shall not exceed 20% of the predetermined contamination level, or 10% of the most sensitive range of an assembly with linear scales, or 10% of the lowest significant decade for an assembly with logarithmic scales.

7.1.3 *Method of test for alpha contamination monitors*

Subject the sensitive volume of the detector to a uniform field giving an exposure rate of 2.5 mR/h using a ^{137}Cs gamma radiation source. Operate the equipment normally and note the indication.

7.1.4 *Requirements for beta contamination monitors*

a) *Assemblies without background compensation*

For any level of beta contamination sufficient to give an indication greater than 50% of full-scale deflection on the most sensitive range, or 50% of the least significant decade for logarithmic scale assemblies, the indication shall not increase by more than 30% of the reading when the instrument is subjected to an increase of 50 μR/h in gamma radiation exposure rate.

b) *Assemblies with background compensation*

In the presence of gamma radiation of which the exposure rate does not exceed 500 μR/h, the indicated contamination level for any level of beta contamination equal to or greater than that corresponding to 50% of full scale deflection on the most sensitive range, for linearly scaled assemblies, or greater than 50% of the most sensitive decade in the case of logarithmically scaled assemblies shall differ by less than 50% from the indication given by the same level of beta contamination in the presence of an external exposure rate not exceeding 20 μR/h.

7.1.5 *Method of test*

a) For assemblies without background compensation, in the presence of external gamma radiation whose exposure rate is less than 20 μR/h, expose the detector assembly to a test source of beta radiation whose activity is such that it gives a reading greater than 50% of the value of the most sensitive range for a linearly scaled assembly or 50% of the least significant decade in the case of a logarithmically scaled assembly. Note the count rate reading.

Increase the exposure rate to the assembly by 50 μR/h using a source of gamma radiation (^{137}Cs) and again note the count rate reading.

Note. — It may be necessary to repeat this test due to statistical fluctuations.

b) For assemblies with background compensation, set the compensating device for correct operation in the presence of a gamma radiation source (see Sub-clause 7.1.1).

In the presence of external gamma radiation with an exposure rate less than 20 μR/h, expose the detector assembly to a test source of beta radiation of activity as defined in Sub-clause 6.1.2.2. Note the count rate reading.

Increase up to 500 μR/h the exposure rate to which the detector is subjected, employing a gamma source (see Sub-clause 7.1) placed in the position chosen for the above setting. With the beta source in position, operate the instrument in the normal way and note the new count rate which results.

Note. — If necessary, the beta source may be removed between the two tests.

7.2 *Alpha radiation (for beta contamination measuring assemblies)*

7.2.1 *Requirements*

The response of beta contamination measuring assemblies to the reference alpha radiation shall be stated if the detector assembly has an equivalent window thickness of less than 5 mg/cm^2.

For the simultaneous alpha/beta contamination measuring assemblies with separate indication of alpha and beta contamination, the response of the beta channel to alpha radiation shall be less than $\frac{1}{10}$ that of the alpha channel.

7.2.2 *Method of test*

Insert the hand or foot alpha radiation reference source in the assembly and note the indication.

7.3 *Beta radiation (for alpha contamination measuring assemblies)*

7.3.1 *Requirements*

The response of alpha contamination measuring assemblies to the reference beta radiation shall be stated.

For simultaneous alpha/beta contamination measuring assemblies with separate indication of alpha and beta contamination, the response of the alpha channel to beta radiation shall be less than $\frac{1}{20}$ that of the beta channel.

7.3.2 *Method of test*

Insert the hand or foot beta radiation reference source in the assembly and note the indication.

7.4 *Neutron radiation*

7.4.1 *Requirements*

A test for neutron response of the assembly is not mandatory and need to be carried out only if this requirement is specified by the user.

7.4.2 *Method of test*

If the test is required, the method shall be subject to agreement between the manufacturer and the user.

8. Operating characteristics

8.1 *Duration of measurement*

The duration of measurement of a measuring assembly depends upon the sensitivity and accuracy required. The assembly shall fulfil the requirements of this publication within a total duration of measurement not exceeding 15 s.

8.2 *Output signals*

A warning shall be provided that operates when the count rate or the count accumulated during a predetermined time corresponds to a degree of contamination below or exceeding some predetermined threshold value.

The threshold value shall be adjustable and the range of adjustment specified.

There shall be a visual warning at the end of counting if the count corresponds to a degree of contamination below the limit chosen. If the visual warning chosen is coloured, it shall be green.

There shall be a different visual warning, together with an acoustic warning, if the count corresponds to a degree of contamination exceeding the limit chosen. If the visual warning chosen is coloured, it shall be red.

In the case of an assembly for monitoring the hands, there shall be a separate warning for each hand in the case where both hands are monitored simultaneously.

In the case of mixed alpha-beta probes, a supplementary indication shall show which type of contamination is involved.

Apart from the warnings described above, it is recommended that a special warning should be provided to show if there is a fault on the assembly.

8.3 *Statistical fluctuations*

8.3.1 *Requirements*

Because of the random nature of the emission of alpha and beta radiation, the indication of a contamination measuring assembly may exhibit fluctuations about its mean value.

The coefficient of variation of the contamination indication shall be less than the following values:

a) For assemblies without background compensation.

For linear scales:

20% for any contamination level exceeding that corresponding to one-third of the scale maximum on the most sensitive range.

For non-linear scales:

20% for any contamination level exceeding that corresponding to three times that corresponding to the lowest significant graduation on the scale.

b) For assemblies with background compensation.

The above values shall apply for any external gamma radiation exposure rates less than 20 μR/h. The above values may be increased to 35% for a gamma exposure rate of 500 μR/h.

8.3.2 *Method of test*

Insert an appropriate alpha or beta source in the assembly of activity sufficient to give an indication between one-third and one-half of the total deviation (linear scale) or the lowest decade (logarithmic scale).

Take a series of at least 10 readings in accordance with Sub-clause 5.4. After this, the mean value of all the readings and the corresponding coefficient of variation is found. This coefficient shall lie within the limits of Sub-clause 8.3.1.

8.4 *Overload protection*

For radiation intensities greater than that corresponding to full-scale deflection, the indication of the assembly should be out of scale at the higher end of the scale range and then shall remain so. For assemblies with more than one scale range, this requirement shall apply to each scale range.

Compliance with this requirement is tested by submitting the assembly to an intensity of at least 100 times that required to produce full-scale deflection for 5 min.

9. Mechanical characteristics

Although these assemblies are used in a fixed place, they should be designed to be mobile and transportable by hand by two persons. This governs their bulk and weight.

It shall be possible to carry out the operating tests without moving or dismantling the assembly, which means that from the front face or a side face there should be free accessibility to all the controls and settings of the electronic sub-assembly. Access to controls and settings shall be permitted only to authorized persons. Operating tests shall also be possible to verify the correct functioning of the electronic sub-assembly (e.g. background noise below a pre-determined level), and of the assembly as a whole, by means of a reference source.

9.1 *Contamination checking devices*

a) *Monitors and warning assemblies for the hands*

The checking device should comprise at least:

— two detectors facing one another for checking both sides of one hand, or
— two detectors placed side by side for checking one side of both hands.

Under these conditions, checking the contamination of both sides of both hands comprises at the most two operations.

The area to which the detectors are sensitive should be at least 12 cm × 20 cm, and the detectors should be freely accessible for decontamination.

b) *Monitors and warning assemblies for the feet*

The contamination checking device may have only one detector. The minimum area to which the detector(s) is (are) sensitive shall be 15 cm × 35 cm.

Under these conditions, checking the contamination of both feet comprises at the most two operations. Assemblies intended for checking both feet simultaneously should have either two detectors as specified above or one sensitive to a source of area 30 cm × 35 cm.

To avoid contamination of the counter surface and deposit of miscellaneous foreign matter, the surface of the detector should be protected by means of a foil of protective material as thin as practical. This foil shall be changed periodically to avoid an increase in background noise; this operation can be facilitated by having a reserve reel of a foil mounted on the apparatus. It is recommended that the unreeling of the foil and the positioning of a clean portion should be effected by means of a pedal.

9.2 *Initiation of counting*

The counting operation shall be started automatically by placing the hand(s) or the foot (feet) in the proper counting position.

Indication should be given if the hand(s) is (are) moved from the correct position before the counting period is complete. On replacing the hand(s) in the correct position, the reading obtained should be cancelled and the counting period recommenced.

9.3 *Installation*

The detector(s) of assemblies for checking contamination of the hands should be placed at a height of about 1.20 m. The probe of an assembly for checking contamination of the feet shall be placed either at floor level or at a height not exceeding 25 cm.

10. Power supply

10.1 *Mains operation*

Mains operated assemblies shall be designed to operate from single-phase supply voltage in one of the following categories, in accordance with national standards:

— Category 1 127 and/or 220 V;
— Category 2 120 and/or 240 V.

The assemblies shall be capable of operating from mains with a supply voltage tolerance of + 10% and −12% and a supply frequency of 60 ± 1 Hz or 50 ± 1 Hz (nominal single-phase power in the U.S.A. is 117 V and/or 234 V, 60 Hz; nominal single-phase power of 110 V, 50 Hz is an additional standard in the United Kingdom).

10.2 *Mains operation test*

Expose the detector to appropriate sources of radiation of sufficient activity to give a count rate corresponding to approximately 2/3 full-scale deflection on the most and on the least sensitive range for a linearly scaled assembly, or of the extreme decades for a logarithmically scaled assembly. With the supply voltage at its nominal value U_N, take in each case the mean of ten consecutive readings of count rate.

Take in each case the mean of ten consecutive readings with the supply voltage 10% above the nominal value and the mean of ten consecutive readings with the supply voltage 12% below the nominal value. These mean values shall not differ from those obtained with nominal supply voltage by more than ± 10%.

It may be necessary to repeat this test due to statistical fluctuations in the indications.

10.3 *Battery operation*

Since these assemblies are intended for operation in a fixed place, they are normally mains-driven. Nevertheless, an emergency supply should be provided in case of a mains failure.

11. Storage

All assemblies designed for use in temperate regions shall be designed to operate within the specifications of this publication following storage (or transport) without batteries for a period of at least three months in the manufacturer's packaging at any temperature between − 25 °C and + 50 °C. In certain circumstances, more severe specifications may be required, such as capability for withstanding air transport at low ambient pressure.

12. Certificate

A certificate shall accompany each assembly, giving at least the following information: *

— Manufacturer's name or registered trade mark,
— Type of the assembly and serial number,
— Graduation of the scale,
— Scale limits for each measuring range,
— Surface contamination response,
— Response as a function of radiation energy,
— Dependence of response on source position,
— Location and dimensions of the sensitive volume,
— Materials of the wall between the source and the sensitive volume of the detector and surface mass of each of them (in mg/cm²),
— Minimum energy of the beta particles that can be detected.

* See IEC Publication 278, Documentation to be supplied with Electronic Measuring Apparatus.